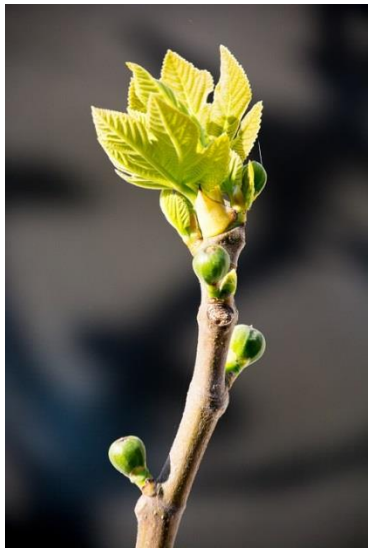
Harvard Forest Schoolyard LTER Research Project: Buds, Leaves, and Global Warming



Monitoring the Growing Season of Deciduous Trees

- Deciduous trees!
- Leaf out/ Bud burst – beginning of season
- Senescence (color change) and Leaf drop – end of season

- Data Trend: LENGTH of SEASON…. Increasing in Massachusetts
- Value to a high school classroom?
  - CITIZEN SCIENCE (contributing to database, group work, long term data, outside, field observation, organizing results in tables and graphs, data analysis, hands on kick off to climate science and tree identification)
  - CLIMATE SCIENCE: Understanding changes to PHENOLOGY…. More important

Yearlong Project…..

- Fall – Observe Leaf Drop (4 or more visits)
- Late fall – Data analysis of the growing season, spring to fall
- Spring – Observe next seasons Leaf Out for next year's class

Integrating into Curriculum: CP Envi. Sci. for Juniors

Unit 3: Harvard Forest Buds/Leaves/Global Warming and Climate Change

- FALL: September – Thanksgiving (at the same time as my soil/planting unit)
  - Harvard Forest Phenology Presentation
    - Focus on science between color change and leaf drop and tying it to climate
    - No explanation of how climate change works yet
  - Begin fall observations
  - Tree Identification – practice and start doing weekly Herbarium Entries
    - Students are creating scientific scrapbooks and using dichotomous keys
  - Climate Change: Greenhouse effect, effects in Massachusetts, effects worldwide
  - Finish fall observations
  - Screening of "Chasing Ice" documentary
- WINTER: Late December – January
  - 1-3 Data manipulation days
    - skills: (data manipulation and analysis, excel, tables, graphing, maintaining skills last exercised before thanksgiving)
    - content: (connecting Harvard Forest content fall to spring, climate change connection as we discuss biomes and expected changes)
- SPRING: April – June
  - Spring observations 6 or more
    - skills: (long term research, groupwork, field observation)
    - content: (gets us doing field work in 2 ways, we also do another spring field study, keeps climate in mind as we study energy)

Tree Identification: Try being my students!

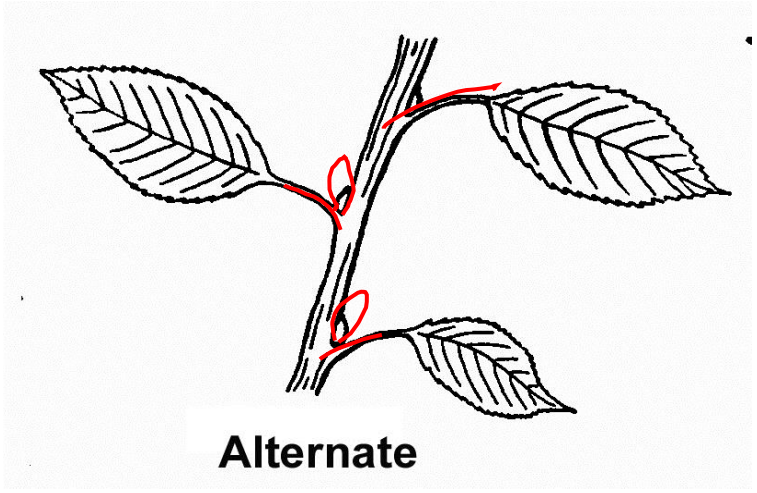
- Each student brings a branch to school as a homework assignment
- I walk through the following power point
- At each slide, they consider what is true for their branch
- After, we use “Tree Finder” dichotomous keys and try to ID their tree.

- Ready to try it? Take out your branch and get ready to take notes!

ALTERNATE or OPPOSITE

Alternate

Everything else!

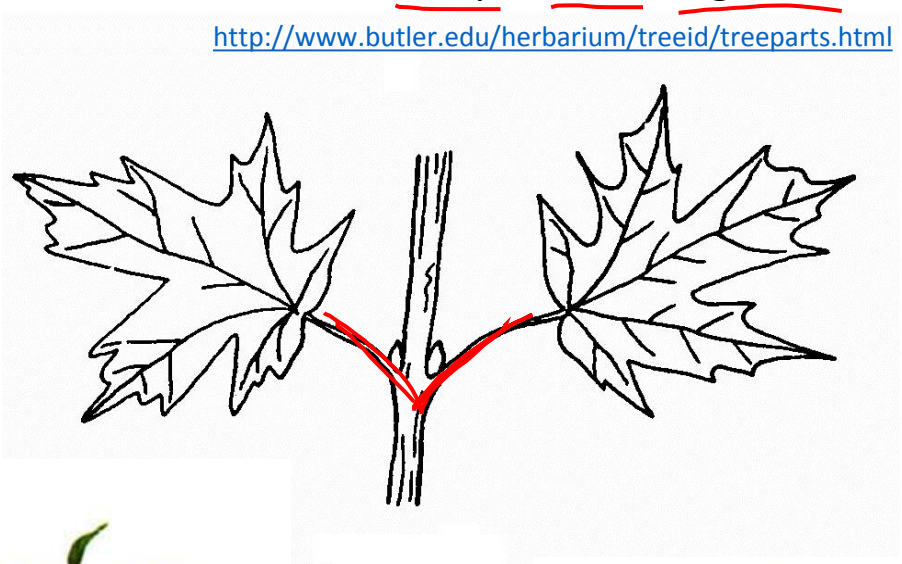


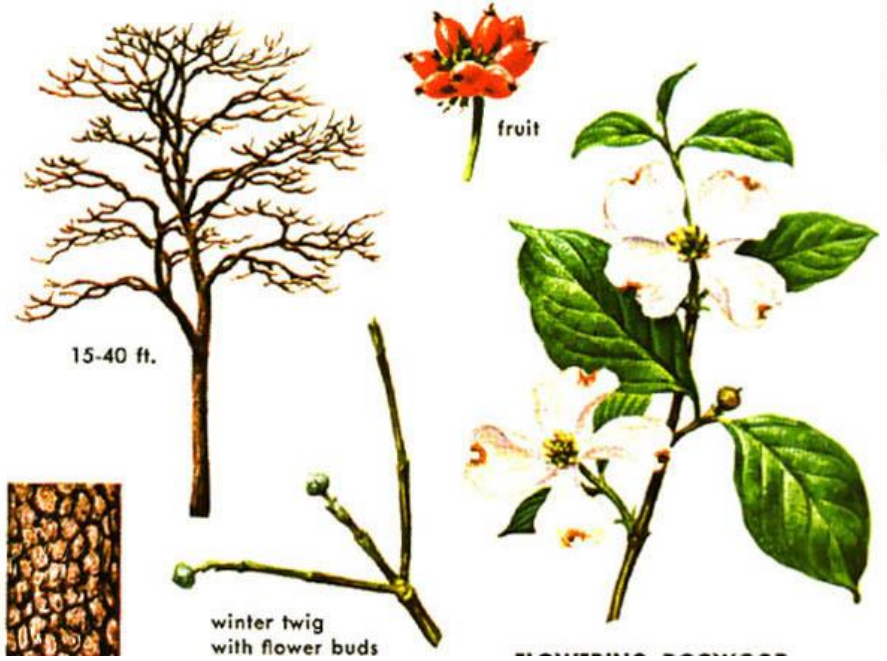
Opposite (MAD)

Very few native trees

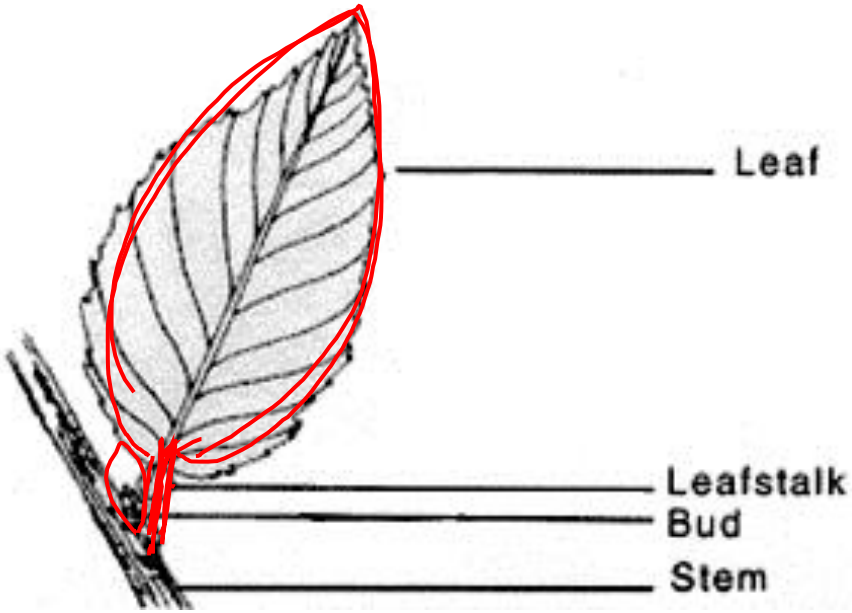
Maple, ash, dogwood

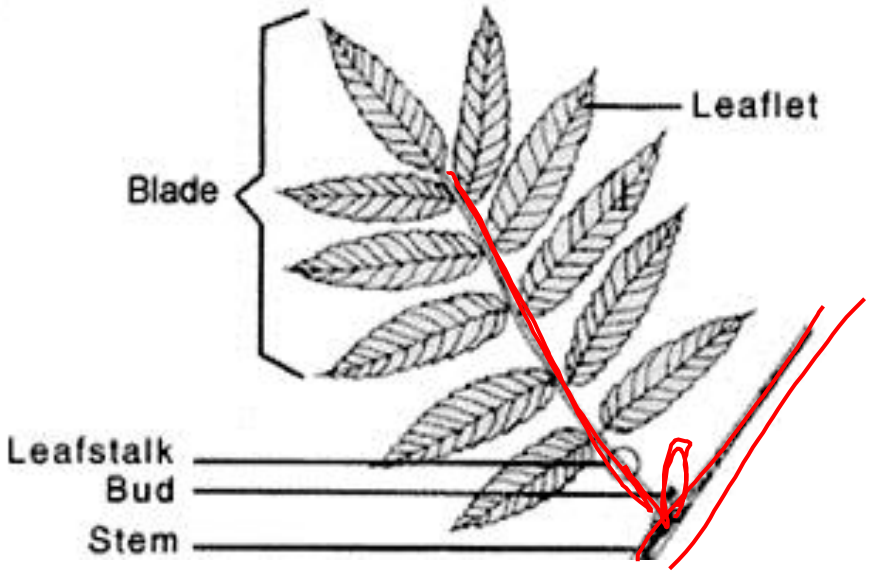
http://www.butler.edu/herbarium/treeid/treeparts.html





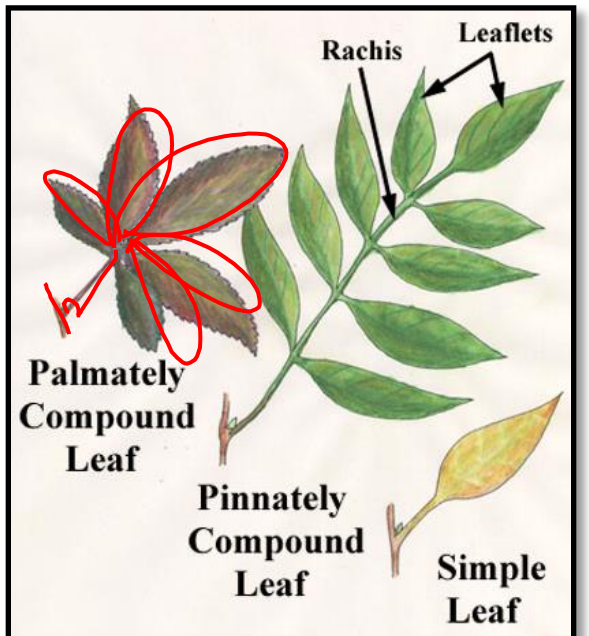
SIMPLE vs. COMPOUND

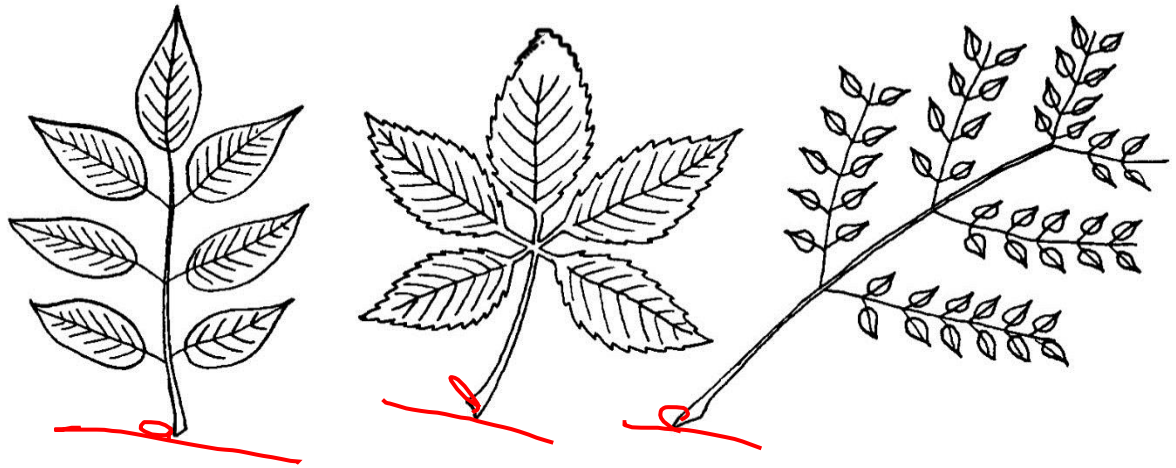




WHERE IS THE BUD?

Leaf stalk: NOT AS WOODY AS BRANCHES

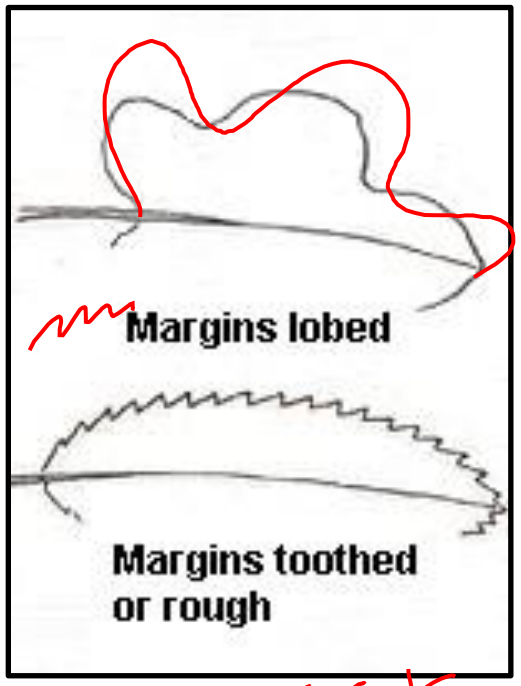


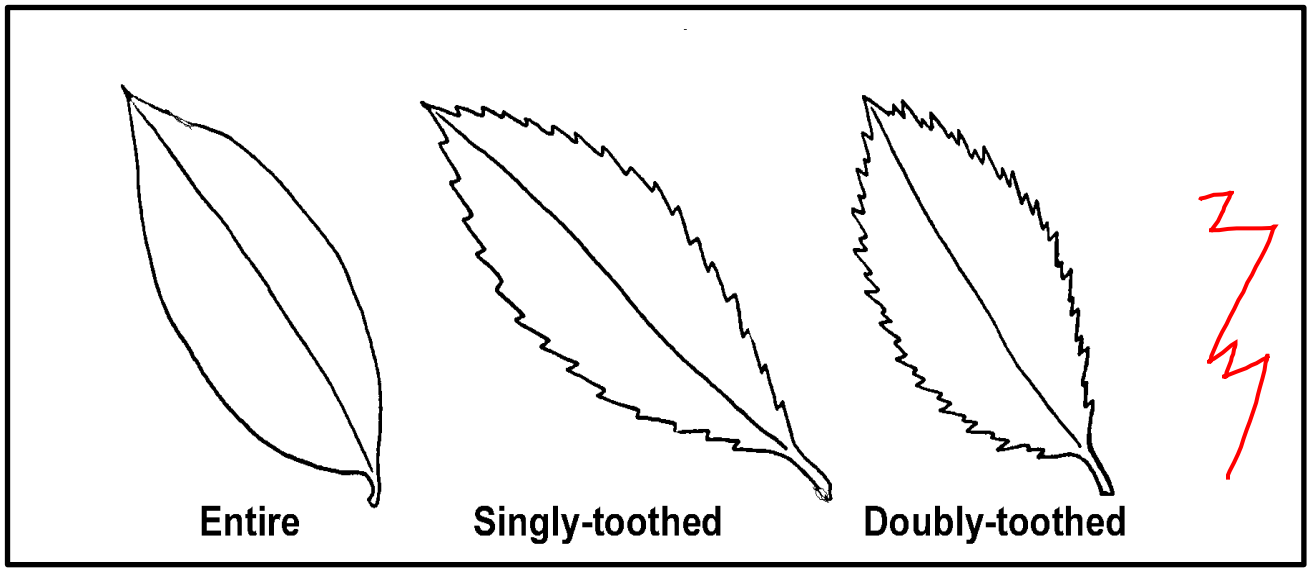


Pinnate Compound Palmate Compound Doubly-Compound

http://www.butler.edu/herbarium/treeid/treeparts.html

MARGINS: Like on paper, they are the EDGES





2 common lobe patterns:

http://www.butler.edu/herbarium/treeid/treeparts.html

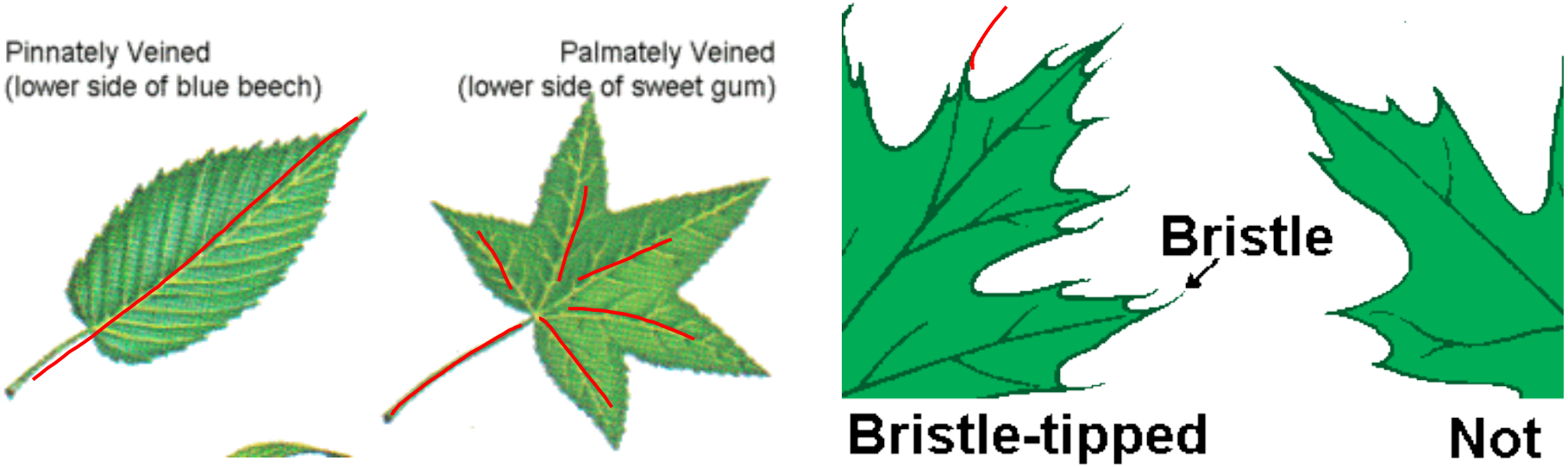
Leaf Veins and Bristles

One main vein (L)

Many main veins (R)

Bristle (L)

No bristle (R)



http://essmextension.tamu.edu/treecarekit/index.php/before-the-storm/tree-identification-and-selection/techniquies-to-identify-trees/

Example ID using this information

- The leaves are opposite, which means it must be a maple, ash, or dogwood
- The leaves are NOT compound, so it must be a maple or a dogwood
- The leaves have 3 big lobes, dogwoods don’t have lobed leaves but maple leaves have 3 lobes
- The notches in the lobes are V shaped, not U shaped, so it cannot be a sugar maple or a Norway maple
- It is a Red Maple! *Acer rubrum*!

- I used Mrs. Matthei’s slides and some maple tree searches on leaf snap for my identification

Try to do your own ID!

- Instead of the “Tree Finder” you can start with the information you just gathered and use websites if you are on the internet.

- Great site my student found (based in Ohio but the ecology is usually similar enough):

http://www.oplin.org/tree/leaf/byleaf.html

Student Herbarium Entry Examples

Jordan Cokinos
10/25/16

Japanese Maple
Acer palmatum

Location:
This tree is located in the middle of my front yard. It is a secluded tree away from any others.

Identification Steps & Sources

Virginia Tech Acer palmatum Fact Sheet:

- leaves:
  - opposite and simple meaning they are set across from each other and they are not composed of leaflets
  - there are 5-7 lobes that are in deep V shapes
  - the lobes have serrated teeth
  - the color of the leaves is commonly a deep red color
- bark:
  - the bark is relatively smooth all over
  - the trunk color is a light grey
- form:
  - the tree is small and stands usually 10-25 feet high
  - the tree's canopy is rounded and branches hang low to the ground
  - the tree is definitely a Japanese Maple or *Acer palmatum* judging by this website

Mrs. Matthei Powerpoint:

- the leaves are opposite which means that it could be either a maple, dogwood, or ash
- leaves are simple and not composed of any leaflets
- the leaves are not entire
- the leaves have 6 lobes
- the lobes have serrated teeth on all of the lobes
- there are 6 main veins radiating through each of the lobes
- the leaves are not bristled
- the tree is some kind of maple but definitely is not any sort of dogwood

Confidence in my ID:

I am 100% confident that the ID of my leaf is a Japanese Maple or *Acer palmatum*. Likewise with my last herbarium entry, the Japanese Maple was deliberately deposited in my front yard so it was easy to get a direct identification of it. I attempted to use the Tree Finder in order to specify exactly what the tree was, but the book led me to every other type of maple but the Japanese Maple. The powerpoint that I used helped me rule out the possibility of the leaf belonging to any kind of dogwood or ash tree and I was also able to conclude that it was a maple tree. Also, the website where I obtained half of my information was the basis for my ID. This resource let me know that I was correct in my self identification and that there was no other tree that it could possibly have been.

Citations:

Seiler, John, Edward Jensen, Alex Niemiera, and John Peterson. "*Acer palmatum Fact Sheet.*" Acer Palmatum Fact Sheet. Virginia Tech Dept. of Forest Resources and Environmental Conservation, 2015. Web. 25 Oct. 2016.

Matthei, Jana. Tree Identification Guide. NDA. 2016. Classroom Powerpoint.

Student Herbarium Entry Examples

Maggie McCloskey

TREE IDENTIFICATION:

Resource 1: powerpoint slides from class

- The leaves are alternate, they are not Maple, Ash, or dogwood
- Leaves are simple there are no clear leaflets and a bud is seen where the leaves are connected to the branch
- The margins are not toothed, they are lobed. It is probably an oak since they have a similar lobe style to the oak on the slides
- There is one main vein and the leaf clearly has pointed bristles at the ends.

I am positive that it is an oak but I am not sure what species of oak it is.

Resource 2: Tree Finder

- Page 5, tree has leaves
- Page 14, leaves with buds are alternate
- Page 21, leaves are simple, no leaflets
- Page 28, leaves are lobed
- Page 33, leaf is not evergreen
- Page 34, tree has no thorns, and is deeply lobed
- Page 51, the leaf is lobed
- Page 53, leaf has more than 4 lobes
- Page 55, leaf is bristle pointed and deeply lobed
- Page 56, end of leaf is not narrow or long
- Page 57, lobes broaden toward tips

I believe that my tree is a Scarlet Oak because it is thin and has enclosing lobes and it has a yellowish rib.

CONFIDENCE IN MY ID:

I am very confident that my tree is an oak tree due to it's alternating leaves, lobes, and because it has simple leaves. I am confident because Tree Finder confirmed that it is an oak tree. I am pretty confident that my oak tree is a scarlet oak because the leaf is very thin and delicate, and because it has enclosing lobes. I am 100% sure my tree is an oak, and I am 95% sure my tree is a scarlet oak. If I messed up and my tree is not a scarlet oak, I think it could be a Hill's or Jack's oak because they share many similar characteristics. However, I don't believe it is either of these types of oaks however, because my leaf is not shiny or dark green, and the tree is not untidy.

Watts, May Theilgaard. Tree Finder: A Manual for the Identification of Trees by Their Leaves. 3rd ed. Rochester, NY: Nature Study Guild, 1998. Print.

Matthei, Jana. Tree Identification Guide. NDA, 2016. Classroom Powerpoint. October 2016

LOCATION:

The large tree in front of my house.

Scarlet Oak

Quercus coccinea

Maggie McCloskey

SCARLET OAK

Quercus coccinea

Student Fall Season and DATA….. NDA Hingham

Fall Observations: Mid September – Mid November

- 9/24 – 11/13 last year ; 9/28 - ? this year
- Once a week
- ~6 observations total
- groups of 2/3 to a tree
- Each 15-20 minutes after the first 40 minute observation

Assessments (Grade each observation):

- Sketch both branches; sketch changes after
- Fill out individual branch pages each time
- Add to Louise Levy's summary page, taped to a folder containing sketches and individual branch pages

Student Spring Season….. NDA Hingham

Spring Observations: Late March– Late May

- 3/29 – 5/31 this year
- Once a week
- 6 observations total
- Same students working in the same groups of 2/3
- Each 15-20 minutes after the first 40 minute observation

Assessments (Grade each observation):

- Sketch both branches; sketch changes after
- Add to Louise Levy's summary page, taped to a folder containing sketches and individual branch pages

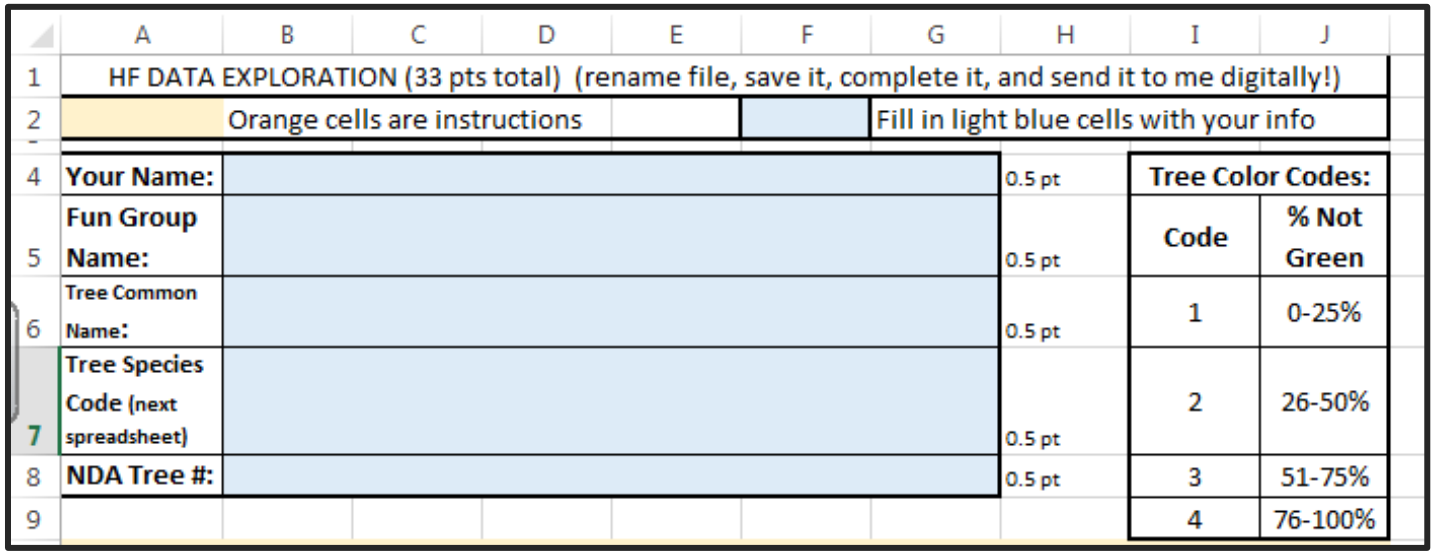
Overall **Growing Season** – Spring to Fall

- Data manipulation occurs in the late fall, using their data and Spring data from the last class

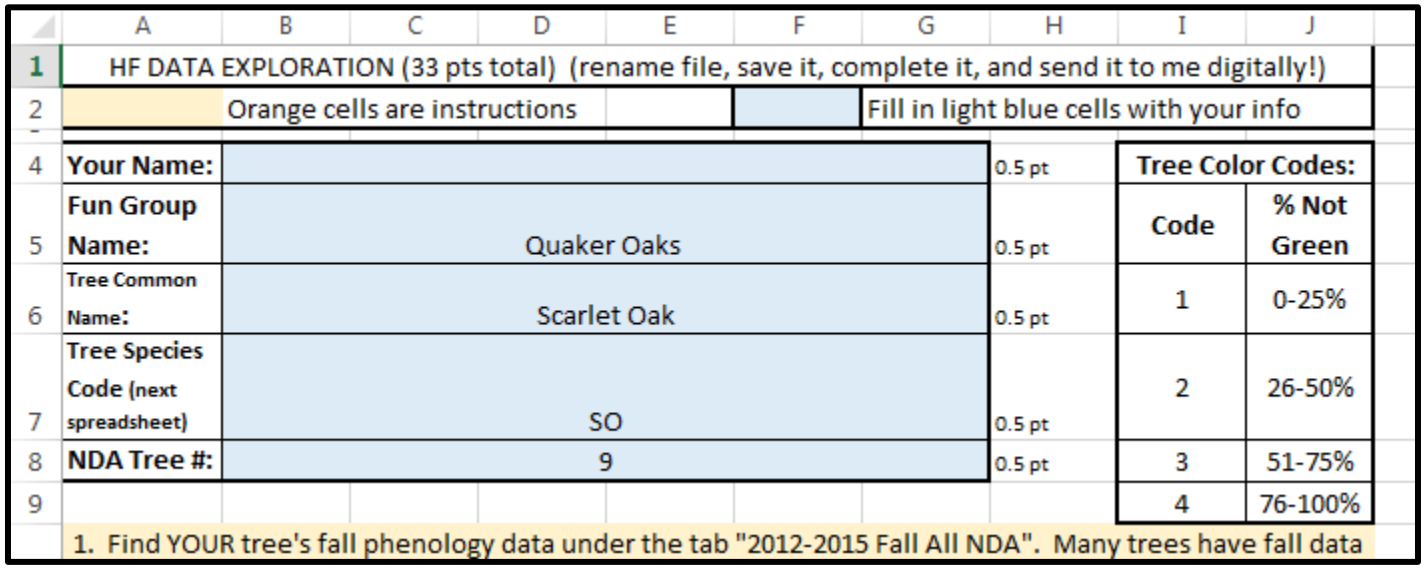
Student Fall Season and DATA….. NDA Hingham

Data Manipulation

- I submitted data to Harvard Forest
- I created a blank data table spreadsheet file (using data from the Harvard Forest website)
- Students saved the blank file as their own and added to it
- Graded as a lab grade; took 80 minute class and then two 40 minute follow ups; completed for homework.



	A	B	C	D	E	F	G	H	I	J
1	HF DATA EXPLORATION (33 pts total) (rename file, save it, complete it, and send it to me digitally!)									
2		Orange cells are instructions						Fill in light blue cells with your info		
4	**Your Name:**							0.5 pt	**Tree Color Codes:**	
5	**Fun Group Name:**							0.5 pt	**Code**	**% Not Green**
6	**Tree Common Name:**							0.5 pt	1	0-25%
7	**Tree Species Code (next spreadsheet)**							0.5 pt	2	26-50%
8	**NDA Tree #:**							0.5 pt	3	51-75%
9									4	76-100%



	A	B	C	D	E	F	G	H	I	J
1	HF DATA EXPLORATION (33 pts total) (rename file, save it, complete it, and send it to me digitally!)									
2		Orange cells are instructions						Fill in light blue cells with your info		
4	**Your Name:**							0.5 pt	**Tree Color Codes:**	
5	**Fun Group Name:**	Quaker Oaks						0.5 pt	**Code**	**% Not Green**
6	**Tree Common Name:**	Scarlet Oak						0.5 pt	1	0-25%
7	**Tree Species Code (next spreadsheet)**	SO						0.5 pt	2	26-50%
8	**NDA Tree #:**	9						0.5 pt	3	51-75%
9									4	76-100%
	1. Find YOUR tree's fall phenology data under the tab "2012-2015 Fall All NDA". Many trees have fall data									

Harvard Forest Schoolyard Database…..

- Submit data
- Download any data in excel format
- Graph data online

Database:

http://harvardforest2.fas.harvard.edu/asp/hf/php/k12/k12_project.php

Data file: want to be my student again?

http://harvardforest.fas.harvard.edu/schoolyard/lesson-plans

- Go to this page, find Matthei.2016. MAST Student Data Worksheet

Levy. 2010. **Data organizers for transferring field data to computer.**
Levy. 2011. **Belchertown HS: lots goin' on.**
Levy. 2013. **Match a Leaf Activity.**
Levy. 2014. **Tell the Story of Our Tree**
Levy. 2015. **Micro-Directions for Buds, Leaves, Global Warming Related Activities**
Levy. 2015. **Student Instructions for Entering Buds, Leaves Data onto Online Database**
Lucia. 2012. **Talking Trees (7th grade).**
Lucia. 2014. **Exploring the Harvard Forest Data Base.**

Lucia. 2014. **Making Sense of Data; Exploring the Harvard Forest Tree Study Data Base.**

Matthei. 2016. **MAST Student Data Worksheet.**
Matthei. 2016. **Student Phenology Report Sample 1**
Matthei. 2016. **Student Phenology Report Sample 2**

My Student Data File: Overview

- **(1 and 2) TABLE** Creating a Table with This Year's Data
  - Copy from other tab
  - Review for accuracy
- **(3) GRAPH**: tree color and percentage of leaves fallen
  - Use data from table 1
  - Calculate date when 50% have fallen.
  - **(4)** Consider 50% leaf drop data accuracy….

- **(5) CONSIDER PATTERNS (HISTORY, FOR A SPECIES)** Consider your trees historical data and compare it to others of its species
- **(6) Explore data…** Ask your own question that you will answer with a graph, create the tables needed to make the graph, analyze your graph.

Beginning of Student Data Page

- Fun group name
- Tree Species Code and #

Blue Cells –

Orange Cells –

HF DATA EXPLORATION (33 pts total) (rename file, save it, complete it, and send it to me digitally!)

Orange cells are instructions | Fill in light blue cells with your info

Your Name:		0.5 pt
Fun Group Name:		0.5 pt
Tree Common Name:		0.5 pt
Tree Species Code (next spreadsheet)		0.5 pt
NDA Tree #:		0.5 pt

Tree Color Codes:	
Code	**% Not Green**
1	0-25%
2	26-50%
3	51-75%
4	76-100%

1. Find YOUR tree's fall phenology data under the tab "2012-2015 Fall All NDA". Many trees have fall data for many years, find the data for 2015 ONLY, this is what you collected. Copy it below. At most you should have 6 observations, not all trees had 6 - this is okay. (1 pt)

School Code	**Teacher**	**Date**	**Julian Date**	**Tree ID**	**Species Code**	**Total Leaves**	**Fallen Leaves**	**Tree Color (see key above)**	**Percent Fallen**

Student Data | Species Codes | 2012-2015 FALL ALL NDA | Historical Data NDA | All HF c

	A	B	C
1	Species Code	Species Name	Scientific Name
2	AD	Alternate-leaved Dogwood	Cornus alternifolia
3	AL	Speckled Alder	Alnus incana
4	AP	Apple	Malus domestica
5	AS	American Sycamore	Platanus occidentalis
6	BA	Black Ash	Fraxinus nigra

Data Table 1: NDA schoolyard Fall phenology for all study years

School Code	Teacher	Date	Julian	Tree ID	Species Code	Total Leaves	Fallen Leaves	Tree Color	Percent Fallen
NDH	Lockett	9/26/2012	270	1	BO	6	0	1	0%
NDH	Lockett	9/27/2012	271	1	BO	6	0	1	0%
NDH	Lockett	10/12/2012	286	1	BO	12	0	2	0%
NDH	Lockett	10/18/2012	292	1	BO	12	0	2	0%
NDH	Lockett	10/26/2012	300	1	BO	12	0	2	0%
NDH	Lockett	11/19/2012	324	1	BO	12	5	4	42%
NDH	Loux-Tu	9/25/2013	268	1	BO	12	0	1	0%
NDH	Loux-Tu	10/3/2013	276	1	BO	12	0	1	0%
NDH	Loux-Tu	10/11/2013	284	1	BO	12	0	1	0%
NDH	Loux-Tu	10/24/2013	297	1	BO	12	0	1	0%
NDH	Loux-Tu	11/5/2013	309	1	BO	12	0	3	0%
NDH	Loux-Tu	11/26/2013	330	1	BO	12	0	4	0%
NDH	Loux-Tu	12/4/2013	338	1	BO	12	5	4	42%
NDH	Loux-Tu	10/14/2014	287	1	BO	12	0	1	0%
NDH	Loux-Tu	10/20/2014	293	1	BO	12	5	2	42%
NDH	Loux-Tu	10/29/2014	302	1	BO	12	5	2	42%
NDH	Loux-Tu	11/5/2014	309	1	BO	12	6	4	50%
NDH	Loux-Tu	11/13/2014	317	1	BO	12	8	4	67%
NDH	Loux-Tu	10/21/2015	294	1	BO	12	0	1	0%
NDH	Loux-Tu	10/30/2015	303	1	BO	12	1	1	8%
NDH	Loux-Tu	11/2/2015	306	1	BO	12	1	2	8%
NDH	Loux-Tu	11/13/2015	317	1	BO	12	4	4	33%
NDH	Lockett	9/26/2012	270	2	PC	6	0	1	0%
NDH	Lockett	9/27/2012	271	2	PC	6	0	1	0%
NDH	Lockett	10/12/2012	286	2	PC	12	0	1	0%
NDH	Lockett	10/18/2012	292	2	PC	12	0	4	0%

Student Data | Species Codes | 2012-2015 FALL ALL NDA

								4	76-100%

1. Find YOUR tree's fall phenology data under the tab "2012-2015 Fall All NDA". Many trees have fall data for many years, find the data for 2015 ONLY, this is what you collected. Copy it below. At most you should have 6 observations, not all trees had 6 - this is okay. (1 pt)

School Code	Teacher	Date	Julian Date	Tree ID	Species Code	Total Leaves	Fallen Leaves	Tree Color (see key above)	Percent Fallen

2. Look over the numbers, do you see how they relate to the folder? Check the data - was it entered correctly? If not, fix it and explain why in the blue cell below. If it was correct, change the cell below to "correct, no change" (0.5 pt)

Not correct- what did you change and why? (delete all text that was here when you answer)

1 and 2 This Year's Data

- Copy from other tab
- Review for accuracy

			Code	% Not Green
Fun Group Name:	Loco Honey Locust	0.5 pt		
Common Name:	Honey Locust	0.5 pt	1	0-25%
Tree Species Code (next spreadsheet)	HL	0.5 pt	2	26-50%
NDA Tree #:	6	0.5 pt	3	51-75%
			4	76-100%

1. Find YOUR tree's fall phenology data under the tab "2012-2015 Fall All NDA". Many trees have fall data for many years, find the data for 2015 ONLY, this is what you collected. Copy it below. At most you should have 6 observations, not all trees had 6 - this is okay. (1 pt)

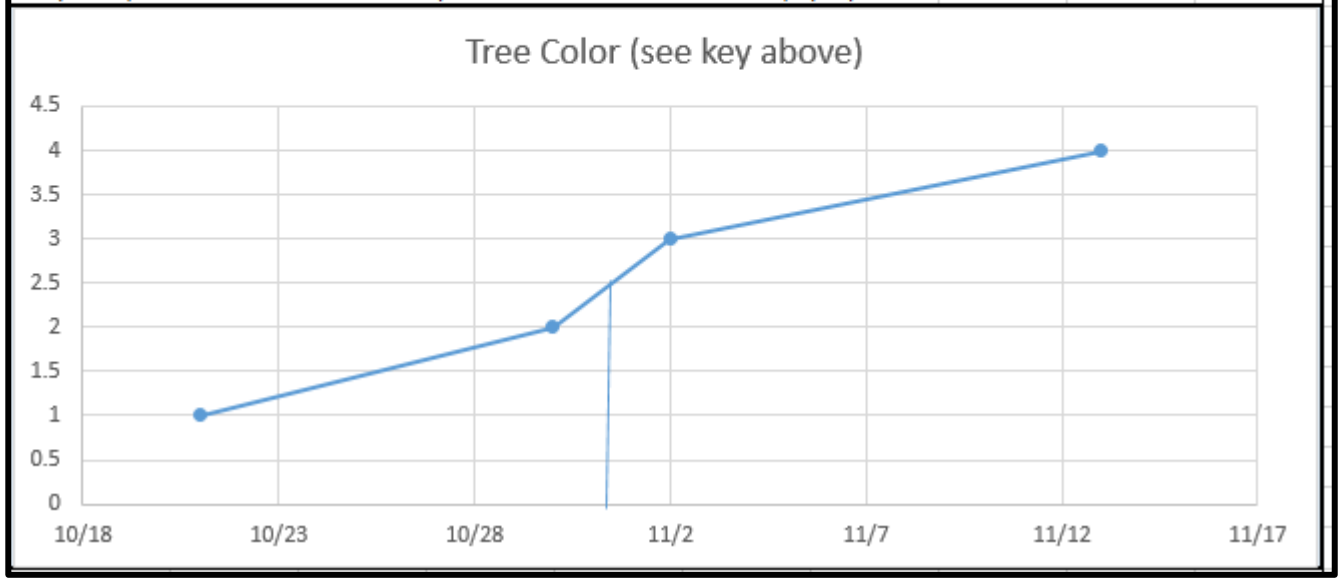
School Code	Teacher	Date	Julian Date	Tree ID	Species Code	Total Leaves	Fallen Leaves	Tree Color (see key above)	Percent Fallen
NDH	Loux-Turn	10/9	282	6	HL	12	0	1	0%
NDH	Loux-Turn	10/16	289	6	HL	12	0	2	0%
NDH	Loux-Turn	10/21	294	6	HL	12	6	2	50%
NDH	Loux-Turn	10/30	303	6	HL	12	6	4	50%
NDH	Loux-Turn	11/2	306	6	HL	12	6	4	50%
NDH	Loux-Turn	11/13	317	6	HL	12	12	4	100%

2. Look over the numbers, do you see how they relate to the folder? Check the data - was it entered correctly? If not, fix it and explain why in the blue cell below. If it was correct, change the cell below to "correct, no change" (0.5 pt)

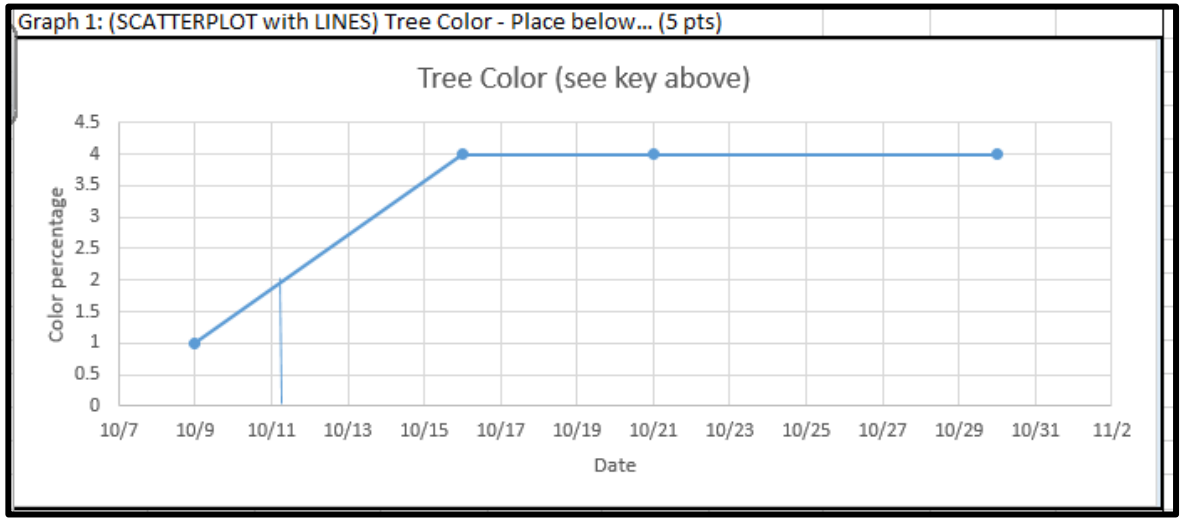
Correct, no change

3. Graph tree color (graph 1) and percent of leaves fallen (graph 2) for the fall of 2015. Use scatterplots with linear lines of best fit. Place both graphs in the space below. Label both axes and give each graph a title. Use date for the x axis (you can use the normal dates. The Julian date is the day of the year (January 1st is Julian Day 1), we use this later so that we can calculate the # of days the trees had leaves on them.

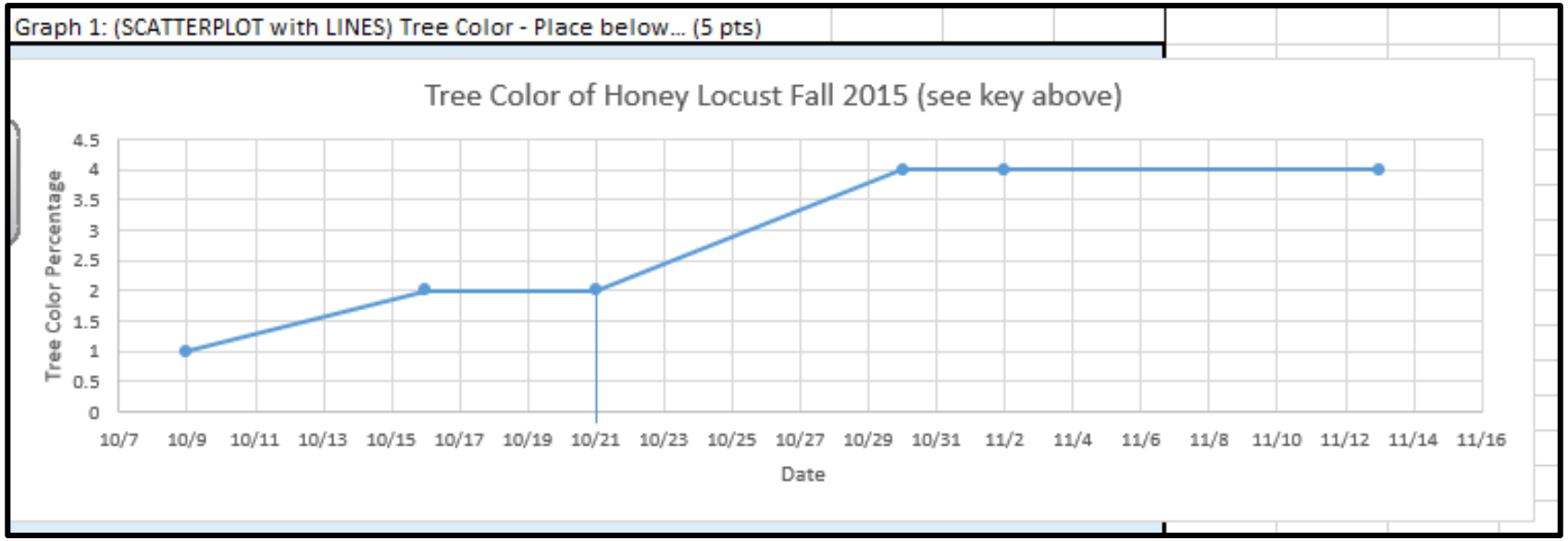
Graph 1: (SCATTERPLOT with LINES) Tree Color - Place below... (5 pts)



Graph 1: (SCATTERPLOT with LINES) Tree Color - Place below... (5 pts)

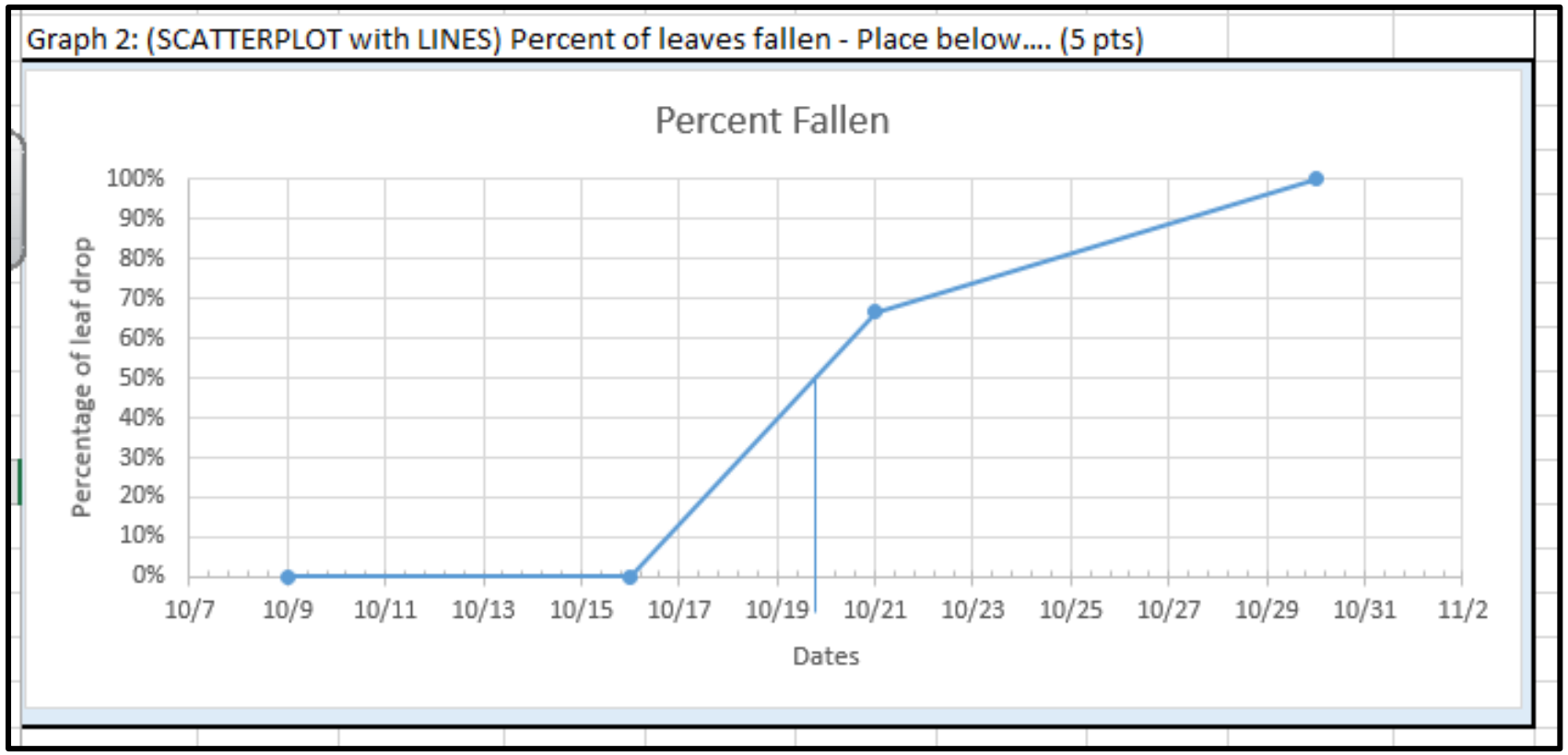


Graph 1: (SCATTERPLOT with LINES) Tree Color - Place below... (5 pts)



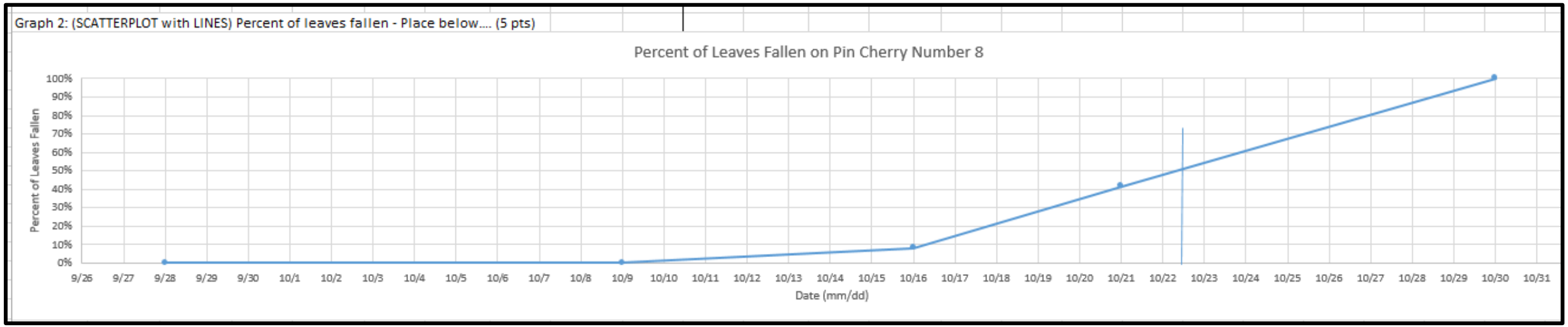
3. 2 graphs: tree color and percentage of leaves fallen

- Use data from table 1



3. 2 graphs: tree color and percentage of leaves fallen

- Calculate date when 50% have fallen.



5. Look at the Historical Data NDA tab. Copy the rows for your tree species below (ALL NDA study trees with your species code). Did you calculate the same 50% leaf drop day as me and the HF data managers? What else do you notice about your study tree (compared to all other study trees, compared to others of its species).

Fill in table below with data (1 pt)

Tree Identification		End of Growing Season 2012		End of Growing Season 2013		Growing Season 2014 (number of days)					Growing Season 2015 (number of days)				
Tree Common Name	Tree #	Start of Growing Period JULIAN Date (50% Leaf emergence) 2012	End of Growing Period (50% Leaf Drop 2012)	Start of Growing Period JULIAN Date (50% Leaf emergence) 2013	End of Growing Period (50% Leaf Drop 2013)	Start of Growing Period Date (50% Leaf emergence) 2014	Start of Growing Period JULIAN Date (50% Leaf emergence) 2014	End of Growing Period (50% Leaf Drop 2014)	End of Growing Period JULIAN date (50% Leaf Drop 2014)	Overall Growing Period 2014	Start of Growing Period (50% Leaf emergence 2015	Start of Growing Period JULIAN Date (50% Leaf emergence) 2015	End of Growing Period (50% Leaf Drop 2015)	End of Growing Period JULIAN date (50% Leaf Drop 2015)	Overall Growing Period 2015

Answer 2 ?'s for 5 here. Questions restated in the answer box, you can delete them as you answer. (1 pt)

Did you calculate the same 50% leaf drop day as me and the HF data managers? What else do you notice about your study tree (compared to all other study trees, compared to others of its species)

1pt

Student Data | Species Codes | 2012-2015 FALL ALL NDA | Historical Data NDA | All HF data ...

5. Consider your trees historical data and compare it to others of its species

Data Table Group 2: Historical Data for ALL NDA study trees. This summarizes 50% leaf drop, 50% leaf out, and overall growing season for all years that they are available.

Table 2a: All of the Data, including the calculations for Julian Date and Growing Period

Tree Identification		End of Growing Season 2012		End of Growing Season 2013		Growing Season 2014 (number of days)					Growing Season 2015 (number of days)				
Tree Common Name	Tree #	Start of Growing Period JULIAN Date (50% Leaf emergence) 2012	End of Growing Period (50% Leaf Drop 2012)	Start of Growing Period JULIAN Date (50% Leaf emergence) 2013	End of Growing Period (50% Leaf Drop 2013)	Start of Growing Period Date (50% Leaf emergence) 2014	Start of Growing Period JULIAN Date (50% Leaf emergence) 2014	End of Growing Period (50% Leaf Drop 2014)	End of Growing Period JULIAN date (50% Leaf Drop 2014)	Overall Growing Period 2014	Start of Growing Period (50% Leaf emergence 2015	Start of Growing Period JULIAN Date (50% Leaf emergence) 2015	End of Growing Period (50% Leaf Drop 2015)	End of Growing Period JULIAN date (50% Leaf Drop 2015)	Overall Growing Period 2015
Black Oak	1					5/7/2014	127	11/13/2014	309	182	5/9/2015	130			
Black Cherry	2	10/22/2012	296	10/4/2013	278	5/2/2014	122	10/14/2014	287	165	5/2/2015	123			
Red Maple	4	10/21/2012	295	10/5/2013	279	5/7/2014	127	10/16/2014	289	162	5/29/2015	150	10/21/2015	295	145

6. Now its time to use the spreadsheets to the right to play with data and make your own graphs. Make 1 or 2 graphs on your own and explain them. Read A-G and then explore the spreadsheets. Each spreadsheet has an example that walks through my Step A-G for a question I asked while looking at that spreadsheet. Do not re-ask the EXACT question I asked (ex. for 2012-2015 Fall All NDA tab: red maple group - don't graph % fallen leaves for the study years, but you could graph tree color; other groups could graph % fallen leaves or tree color).

A. Look over the spreadsheets to the right of this one, consider what data you find on each.

B. Decide what question you want to ask. (Ex. how was my tree's fall leaf drop or color change pattern different this year compared to past years?)

C. Determine what info you need to make a graph that answers your question. (Ex. above - use 2012-2015 Fall All data)

D. Re-sort data as you need to in the spreadsheets so that it is easy to copy and paste. (use the sort tabs already there, or do a custom sort (home - sort & filter - custom sort) to sort first by one column, then by another)

E. Copy and paste the data you would need to make the graph into a table below (include the column titles)

F. You may have to reorganize the data depending on the type of graph you make (Scatterplots: time, or the "x" should have a column, and each "y" line you plot should have a column; you may need to make new columns. Bar graphs: each tree usually should have its own row, so most information will have to be completely reorganized)

G. Make graphs and place them below your data tables! Make sure to label the graph and the axes (y and x).

H. Explain your graphs in the merged cell below. Explain the graph(s), what they are, what patterns you see (analyze the graph), and if the patterns are what you would expect. (6 pts)

A - look through the spreadsheets

B. How does the end date of the growing season of the Honey Locust in 2015 compare to those of 2012, 2013, and 2014? 1pt

C. I will need the dates of the end of the growing season for 2012, 2013, 2014, and 2015. 1pt

D- re-sort data before copying in the original spreadsheet (if you need/want to)

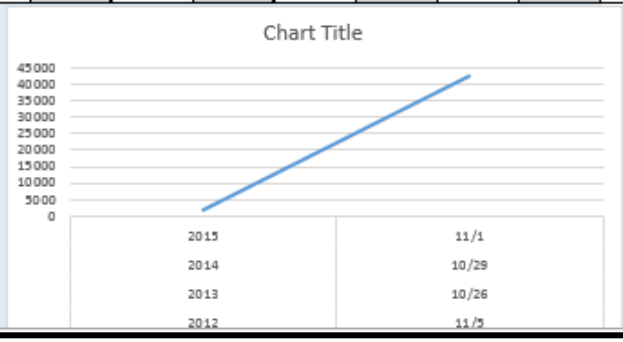
Your E - copy Data tables below.

Your F - reorganize tables as you need to, take all the space that you want.

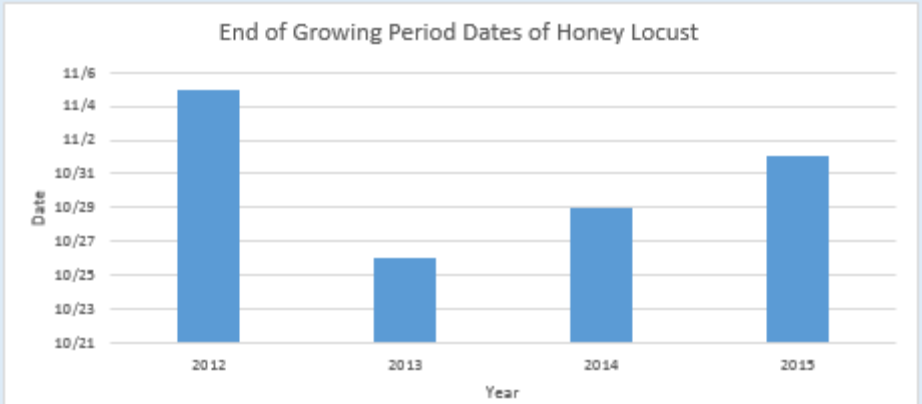
Your G - place graphs below the tables, finalize them, then analyze them in the large merged space above. (2 pts -tables; 5 pts - graph)

Tree Identification		End of Growing		End of Growing		Growing Season 2014 (number of days)					Growing Season 2015 (number of days)				
Tree Common Name	Tree #	End of Growing Period Date (50% Leaf emergence)	End of Growing Period JULIAN (50% Leaf Drop 2012)	End of Growing Period Date (50% Leaf emergence)	End of Growing Period JULLIAN (50% Leaf Drop 2013)	Start of Growing Period Date (50% Leaf emerg	Start of Growing Period JULIAN Date (50% Leaf	End of Growing Period (50% Leaf Drop 2014)	End of Growing Period JULIAN date (50% Leaf Drop	Overall Growing Period 2014	Start of Growing Period (50% Leaf emergence	Start of Growing Period JULIAN Date (50% Leaf	End of Growing Period (50% Leaf Drop 2015)	End of Growing Period JULIAN date (50% Leaf Drop 2015)	Overall Growing Period 2015
Honey Locus	6	11/5	310	10/26	300	5/12	132	10/29	302	170	5/10	130	11/1	306	176

Year	End of Growing Period Date
2012	11/5
2013	10/26
2014	10/29
2015	11/1



Year	2012	2013	2014	2015
End of Growing Period Date	11/5	10/26	10/29	11/1



Student Data | Species Codes | 2012-2015 FALL ALL NDA | Historical Data NDA | All HF data drop, out, season

H.) My graph shows the end of growing period dates of the Honey Locust from 2012 to 2015. It was hard to graph because the axes would get messed up every time I attempted to graph the data. My data table had to be transformed, and one column of the data table had to be graphed at time. With the exception of 2012, the growing period ends later and later each year. In fact, the growing period of the Honey Locust ends four days later every year from 2013 to 2015. This is what we would expect because of climate change, as a warmer climate lengthens the growing period of trees. Because 2012 does not follow this pattern and there is an eleven day gap between 2012 and 2013, 2012 might be an anomaly. 6 pt

A - look through the spreadsheets

I will look through all the data for Honey locust trees in massachusets and by using dates, see which growing season was better than the rest.	1 pt
I used the data from the HF data sheet for all the Honey Locust trees who's data was charted over an eight year period.	1 pt

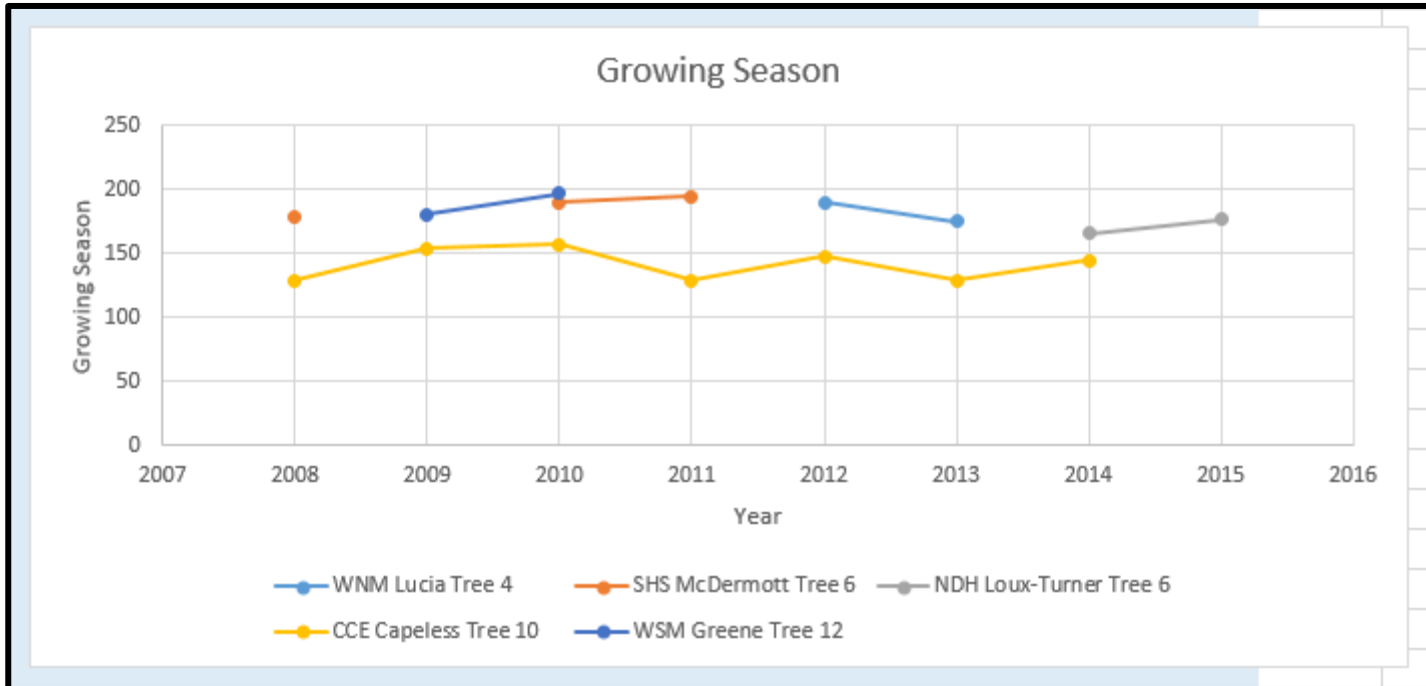
D- re-sort data before copying in the original spreadsheet (if you need/want to)

Your E - copy Data tables below.

Your F - reorganize tables as you need to, take all the space that you want.

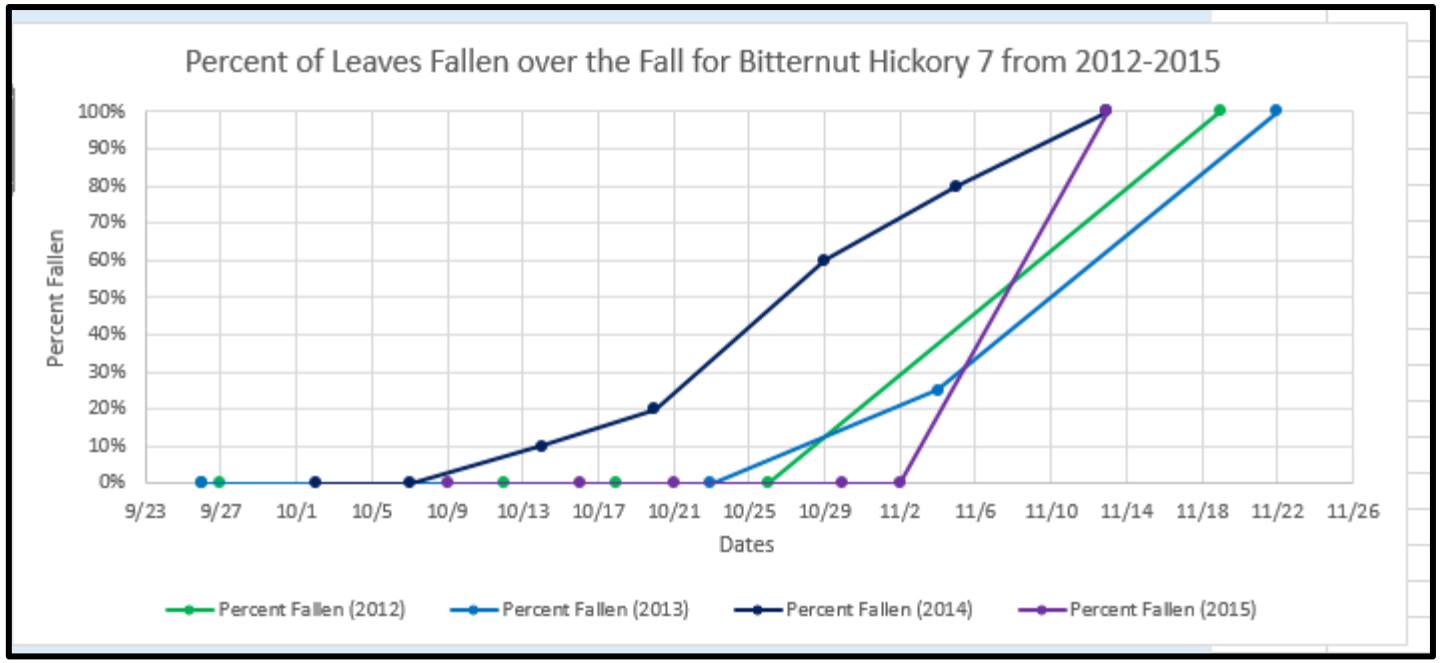
Your G - place graphs below the tables, finalize them, then analyze them in the large merged space above. (2 pts -tables; 5 pts - graph)

School Code	Teacher	Year	2008	2009	2010	2011	2012	2013	2014	2015
WNM	Lucia	Tree 4					190	175		
SHS	McDermo	Tree 6	178		190	195				
NDH	Loux-Turr	Tree 6							166	177
CCE	Capeless	Tree 10	129	154	157	129	148	129	145	
WSM	Greene	Tree 12		181	197					



Your G - place graphs below the tables, finalize them, then analyze them in the large merged space above. (2 pts -tables; 5 pts - graph)

School Code	Teacher	Date	Julian	Tree ID	Species Code	Total Leaves	Fallen Leaves	Tree Color	Percent Fallen
NDH	Lockett	9/26/12	270	7	BH	6	0	1	0%
NDH	Lockett	9/27/12	271	7	BH	6	0	1	0%
NDH	Lockett	10/12/12	286	7	BH	12	0	1	0%
NDH	Lockett	10/18/12	292	7	BH	12	0	3	0%
NDH	Lockett	10/26/12	300	7	BH	12	0	4	0%
NDH	Lockett	11/19/12	324	7	BH	12	12	4	100%
NDH	Loux-Turn	9/26/13	269	7	BH	12	0	1	0%
NDH	Loux-Turn	10/23/13	296	7	BH	12	0	1	0%
NDH	Loux-Turn	11/4/13	308	7	BH	12	3	4	25%
NDH	Loux-Turn	11/22/13	326	7	BH	12	12	4	100%
NDH	Loux-Turn	10/2/14	275	7	BH	10	0	1	0%
NDH	Loux-Turn	10/7/14	280	7	BH	10	0	1	0%
NDH	Loux-Turn	10/14/14	287	7	BH	10	1	2	10%
NDH	Loux-Turn	10/20/14	293	7	BH	10	2	2	20%
NDH	Loux-Turn	10/29/14	302	7	BH	10	6	4	60%



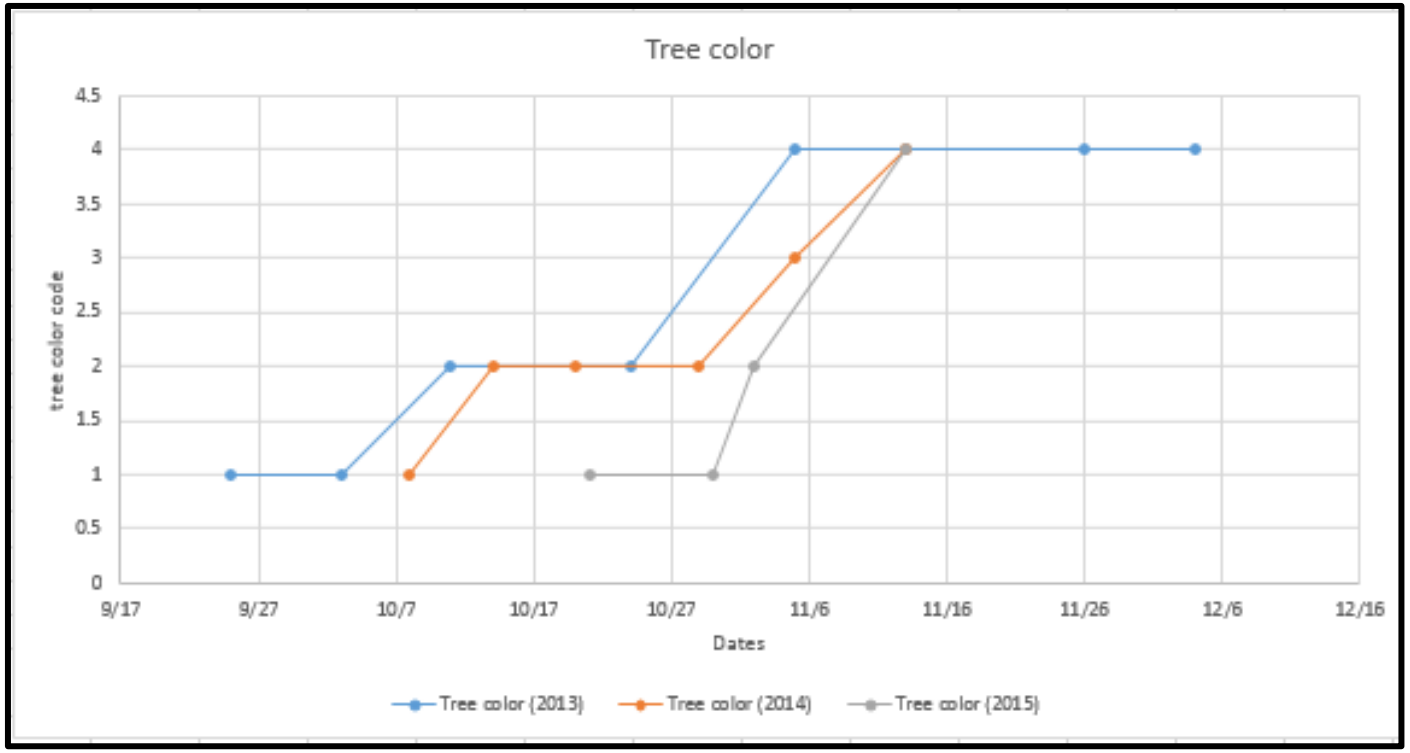
Date	Percent Fallen (2012)	Percent Fallen (2013)	Percent Fallen (2014)	Percent Fallen (2015)
9/26	0%			
9/27	0%			
10/12	0%			
10/18	0%			
10/26	0%			
11/19	100%			
9/26		0%		
10/23		0%		
11/4		25%		
11/22		100%		
10/2			0%	
10/7			0%	
10/14			10%	
10/20			20%	
10/29			60%	
11/5			80%	
11/13			100%	
10/9				0%
10/16				0%
10/21				0%
10/30				0%
11/2				0%
11/13				100%

Your G - place graphs below the tables, finalize them, then analyze them in the large merged space above. (2 pts -tables; 5 pts - graph)

School Code	Teacher	Date	Julian	Tree ID	Species Code	Total Leaves	Fallen Leaves	Tree Color	Percent Fallen
NDH	Loux-Tu	9/25/2013	268	13	SO	12	0	1	0%
NDH	Loux-Tu	10/3/2013	276	13	SO	12	0	1	0%
NDH	Loux-Tu	10/11/2013	284	13	SO	12	0	2	0%
NDH	Loux-Tu	10/24/2013	297	13	SO	12	0	2	0%
NDH	Loux-Tu	11/5/2013	309	13	SO	12	6	4	50%
NDH	Loux-Tu	11/26/2013	330	13	SO	12	9	4	75%
NDH	Loux-Tu	12/4/2013	338	13	SO	12	9	4	75%
NDH	Loux-Tu	10/8/2014	281	13	SO	12	0	1	0%
NDH	Loux-Tu	10/14/2014	287	13	SO	12	1	2	8%
NDH	Loux-Tu	10/20/2014	293	13	SO	12	4	2	33%
NDH	Loux-Tu	10/29/2014	302	13	SO	12	6	2	50%
NDH	Loux-Tu	11/5/2014	309	13	SO	12	6	3	50%
NDH	Loux-Tu	11/13/2014	317	13	SO	12	7	4	58%
NDH	Loux-Tu	10/21/2015	294	13	SO	12	0	1	0%
NDH	Loux-Tu	10/30/2015	303	13	SO	12	1	1	8%
NDH	Loux-Tu	11/2/2015	306	13	SO	12	1	2	8%
NDH	Loux-Tu	11/13/2015	317	13	SO	12	1	4	8%

As we can see, since 2013 the tree color started after. This is caused by the climate change because the weather gets warmer and alterate the fenology. Then the three lines goes at the same point but again, the leaves needs more days to change their color because the weather.

6 pt



Date	Tree color (2013)	Tree color (2014)	Tree color (2015)
9/25	1		
10/3	1		
10/11	2		
10/24	2		
11/5	4		
11/26	4		
12/4	4		
10/8		1	
10/14		2	
10/20		2	
10/29		2	
11/5		3	
11/13		4	
10/21			1
10/30			1
11/2			2
11/13			4